

ARM Cloud Modeling and Parameterization Working Group Model Intercomparison

Procedures for Case 4: Spring ARM SCM IOP: March 1 to March 22, 2000

Minghua Zhang¹, Richard T. Cederwall², Shaocheng C. Xie²,
J. John Yio², and Steven K. Krueger³

1. SUNY Stony Brook
2. LLNL
3. U. Utah

This document is available from the ARM SCM Case 4 Intercomparison Web page <http://dev.www.arm.gov/docs/scm/scmic4> (Version under review, by CPM WG, Feb. 11 - 19, 2003.) An updated version will appear at the official ARM Web site (<http://www.arm.gov/docs/scm/scmic4>), with any necessary revisions incorporated.

1 Introduction

1.1 Strategy

Case 4 is formulated to address the parameterization of clouds in climate models by using ARM data and by building on the ARM/GCSS intercomparison experiences from previous cases.

The science theme of Case 4 is: what determines the cloud amount in observations and in models? The outcome of the intercomparison is to improve the parameterization of the physical processes that determine cloud amount in climate models.

Case 4 is based on the **22**-day ARM (Atmospheric Radiation Measurement program) SCM IOP that took place at the Southern Great Plains site in March 2000. This IOP overlapped with a comprehensive cloud IOP, and thus special measurements of cloud microphysical properties from aircraft measurements are also available.

1.2 Case 4 Description

The entire March 2000 ARM SCM IOP is divided into six periods, each with distinctive synoptic weather and cloud distributions. Figure 1 shows the observed precipitation over the SGP SCM domain, and Figure 2 shows the cloud frequency from the ARM ARSCL product at the CART central facility. In both figures, the six periods are marked.

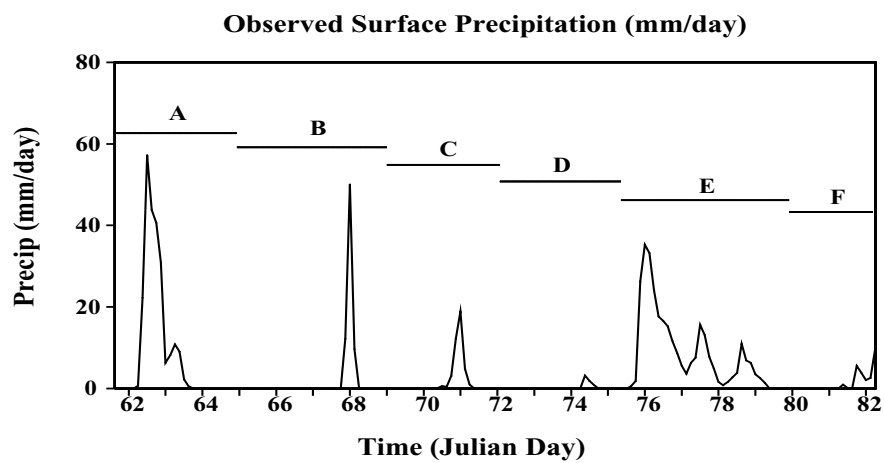


Figure 1. Time series of the observed surface precipitation rates during the March 2000 IOP.

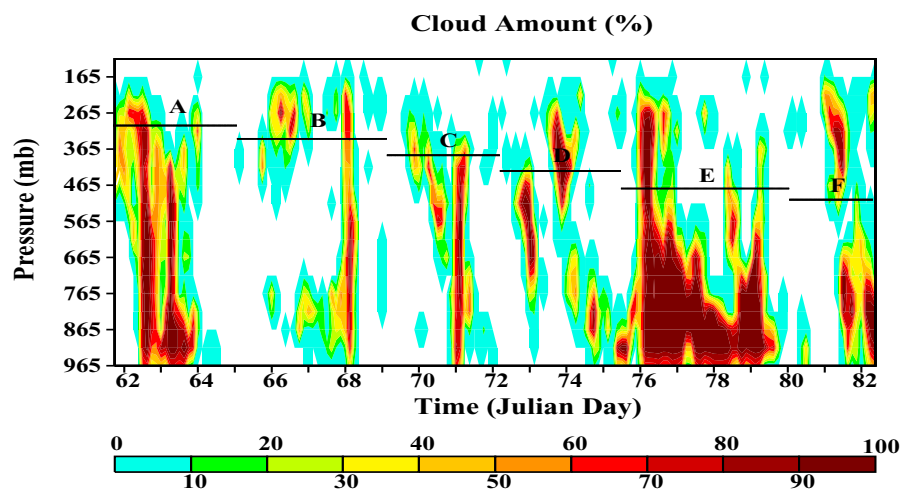


Figure 2. Time-pressure cross-section of the ARSCL cloud frequency during the March 2000 IOP.

A brief summary of the six periods is as follow. More detailed descriptions can be found at the Case 4 website.

- A: Clouds associated with synoptic cyclogenesis over the ARM SGP (3/1-3/4)
- B: Clouds from a cross section of a cold front leg (3/5-3/8)
- C: Non-frontal high clouds associated with an upper level trough (3/9-3/11)
- D: Non-precipitating clouds (3/12-3/15)
- E: Clouds associated with cold front and frontogenesis (3/15-3/19)
- F: Clouds associated with stationary fronts (3/20-3/22)

2 Protocol

2.1. Forcing data and initial condition

Profiles of temperature, water vapor, winds, large-scale advective tendencies of temperature and water vapor are taken from the ARM variational analysis on the Case 4 web page. Time series of surface latent and sensible heat fluxes, surface temperature, and broadband surface albedo are also taken from the ARM variational analysis. Note that the surface temperature is calculated from the SIRS upward and downward longwave radiation, with the assumption of a 0.98 surface emissivity. The broadband surface albedos are derived from the SIRS upward and downward shortwave radiation. In the dataset, we only provide daily averaged surface albedos that are obtained by averaging data samples at 9:30, 12:30, and 15:30. For Case 4, radiative heating rates will not be prescribed. Instead, they will just be calculated from the model.

The Case 4 data set starts at 1730 UTC on March 1 and ends at 0830 UTC on March 22.

For all six events, SCMs and CRMs use the ARM variational analysis as forcing data and initial conditions.

2.2. Experimental Design

SCMs and CRMs (2D and 3D) initialize the models at the beginning of each sub-period and integrate the models for time duration as specified below.

Please note: The last two reported times of each simulation run should bracket the end time as specified for it below – so that data interpolation (to a complete set of analysis times) will be feasible for computing correlation with observation or for comparison with other models. This is required, unless you have taken the trouble to interpolate model data to analysis times.

- A: (nt = 27) day 61.729 to day 64.980, 17:30GMT March 1 to 23:30 GMT March 4
- B: (nt = 33) day 64.979 to day 68.980, 23:30GMT March 4 to 23:30 GMT March 8
- C: (nt = 25) day 68.979 to day 71.980, 23:30GMT March 8 to 23:30 GMT March 11
- D: (nt = 29) day 71.979 to day 75.480, 23:30GMT March 11 to 11:30 GMT March 15
- E: (nt = 37) day 75.479 to day 79.980, 11:30GMT March 15 to 23:30 GMT March 19
- F: (nt = 21) day 79.979 to day 82.479, 23:30GMT March 19 to 11:30 GMT March 22
(in spite of the fact that analysis data has ended at 8:30)

2.3 Forcing specification and CRM specifics

2.3.1 Initial and lower boundary conditions

The initial profiles are based on the observed SGP CART areal averages of temperature, water vapor mixing ratio, and horizontal wind velocity. These are provided as functions of pressure at DP mb intervals from BOT to TOP mb. For the values derived by Zhang's variational analysis, DP = 25 mb, BOT = 965 mb, and TOT = 40 mb. The values provided must be interpolated to each model's vertical grid levels. Note that the lowest layer (BOT = 965 mb) could be below the surface. Please use the provided surface pressure to set the surface boundary condition in your model. \bar{T} , \bar{q} , \bar{u} and \bar{v} at the surface can be obtained by extrapolation if the corresponding surface data are not available. $(\partial\bar{T}/\partial t)_{L.S.}$, $(\partial\bar{q}/\partial t)_{L.S.}$ and $\bar{\omega}$ are assumed to be zero at the surface. Values for model levels below BOT mb can be obtained by interpolation using values at BOT and the surface. To obtain values for model levels above TOP mb by interpolation, the simplest approach is to assume that \bar{T} , \bar{q} , \bar{u} and \bar{v} at 20 km are equal to their values at TOP mb, and that $\bar{\omega}$, $(\partial\bar{T}/\partial t)_{L.S.}$ and $(\partial\bar{q}/\partial t)_{L.S.}$ are equal to zero at 20 km.

Radiative transfer calculations may require temperature, water vapor mixing ratio, and ozone mixing ratio profiles above 20 km. The “standard mid-latitude summer atmosphere” profiles are available for this purpose, and can be found on the SCM Intercomparison web page under SCM Supporting Data Sets.

The lower boundary is a land surface. For this intercomparison, values of surface sensible and latent heat flux are given as surface forcing for the models. The surface forcing terms are obtained from site-wide averages of the observed fluxes by the ARM Energy Balance

Bowen Ratio (EBBR) stations. The surface temperature and the broadband surface albedo are also specified from the observations. For diagnostic purposes, other surface quantities are provided hourly, including surface pressure, soil temperature and moisture, near-surface winds, downwelling solar and IR radiation, and precipitation. The average elevation of the ARM SGP SCM domain is 360 *m*.

2.3.2 Large-Scale Forcing

The large-scale forcing terms in the SCM governing equations include the large-scale horizontal pressure gradient force, and the large-scale advective tendencies of horizontal momentum, temperature, and water vapor mixing ratio. The SCM horizontal grid sizes are considered to be small compared to large-scale disturbances. In this case, the large-scale forcing will be approximately uniform over the model domains. For this reason, the large-scale forcing terms are defined to be functions of height and time only. The available large-scale forcing terms are based on observations averaged over the 12-sided variational analysis grid for SGP CART region (about 370 km across).

The lateral forcing will be specified in two different ways for the intercomparison runs: total (or revealed) forcing, and total plus relaxed forcing. Each is described below.

(1) Specify the observed total tendency

The large-scale advective tendencies for temperature \bar{T} and water vapor mixing ratio \bar{q} are formally defined (on isobaric surfaces) as

$$\left(\frac{\partial \bar{T}}{\partial t} \right)_{L.S.} \equiv -\bar{v} \cdot \nabla \bar{T} - \omega \frac{\partial \bar{T}}{\partial p} + \frac{\omega}{c_p} \alpha$$

and

$$\left(\frac{\partial \bar{q}}{\partial t} \right)_{L.S.} \equiv -\bar{v} \cdot \nabla \bar{q} - \omega \frac{\partial \bar{q}}{\partial p}$$

where ∇ is the horizontal del operator. Note that for potential temperature

$$\left(\partial \bar{\theta} / \partial t \right)_{L.S.} = \left(p_0 / \bar{p} \right)^{R/c_p} \left(\partial \bar{T} / \partial t \right)_{L.S.}$$

The above terms can be calculated from the data provided. Unfortunately, observations of the advective tendencies for hydrometeors are not available. This may have a significant impact on the simulation of middle and upper tropospheric stratiform clouds.

(2) Specify total advective tendency plus relaxation toward observed value

In this method,

$$\left(\partial \bar{T} / \partial t \right)_{L.S.R.} = \left(\partial \bar{T} / \partial t \right)_{L.S.} + \frac{\bar{T} - \bar{T}_m}{\tau_a}$$

and

$$\left(\partial \bar{q} / \partial t\right)_{L.S.R.} = \left(\partial \bar{q} / \partial t\right)_{L.S.} + \frac{\bar{q} - \bar{q}_m}{\tau_a}$$

where \bar{T} and \bar{q} are the observed large-scale temperature and mixing ratio, \bar{T}_m and \bar{q}_m are modeled temperature and mixing ratio, and τ_a is the advective time scale calculated as follows

$$\tau_a = D / 2\sqrt{u^2 + v^2}$$

where D is the distance across the SCM domain (specified here as 370 km), and u and v are the wind components in the column from the analyses.

Profile values are given at 25-mb intervals for the ARM/SUNY variational analysis, and at 3-hour intervals. These values must be interpolated in pressure to the model's grid and in time, as it requires, in order to obtain values at each pressure level. Values are given for temperature, instead of potential temperature, for all terms, and for dry static energy for some terms.

Note: use *Horizontal_Temp_Advec* + *Vertical_s_Advec* for total advective temperature tendency to account for adiabatic compression term. Several temperature terms can be converted to potential temperature using the conversion:

$$\bar{\theta} = \left(p_0 / \bar{p} \right)^{R/c_p} \bar{T}$$

where p_0 is 1000 mb.

2.3.3 Obtaining Forcing and Evaluation Data

Data files containing forcing data and evaluation data are located at the ARM Web site in the SCM/CPM Web page for Case 4. See Section 6 (Time Table), for its location.

The files named layer_0003.dat and surface_0003.dat, both in ASCII text, are strongly recommended. Their corresponding versions in netCDF format, acceptable or nearly acceptable to CCM3, are also available for participants whose simulation code accepts only netCDF data.

Vertical profiles of observed large-scale temperature (\bar{T}), mixing ratio (\bar{q}), and velocity components (\bar{u} , \bar{v} , and $\bar{\omega}$); the observed surface temperature (\bar{T}_s) and the surface pressure (\bar{p}_s); profiles of the observed large-scale *total* advective tendencies of temperature and mixing ratio, $\left(\partial \bar{T} / \partial t\right)_{L.S.}$ and $\left(\partial \bar{q} / \partial t\right)_{L.S.}$, and *horizontal* and *vertical* advective tendencies of temperature and mixing are contained here.

3 Results to Submit

The results to be submitted will consist of *large-scale* quantities unless otherwise noted. Large-scale is defined as both a space and time average, indicated by an overbar. The SCM quantities already represent a space average in the horizontal direction over the SCM domain.

The time average is the average over a 3-hour period, and should be based on “observations” taken frequently enough to avoid aliasing due to cloud-scale and mesoscale variability. Some quantities, such as surface rainfall, should be accumulated every time step. Unless noted otherwise, time averages should be obtained from observations taken every SCM time step (approximately 20 minutes).

The large-scale quantities to be submitted will consist of time series and profiles at 3-hourly intervals. The time series will be largely based on quantities provided in more detail in the profiles, so the latter will be described first.

See the Case 4 Web page for instructions on where and how to submit model results.

3.1. Description of Experimental Quantities

3.1.1 Vertical profile quantities

Submit the results for each quantity listed below as a separate ASCII file in the file format described in 3.2.1. For a quantity not available in your model, a “dummy” file that is empty must be submitted. It bears a proper name (as required of all profile quantities, in Section 3.1.3), but suffixed “.not_submitted”.

Please consider enhancing your code, or building a Unix Shell script, to generate automatically such dummy files for quantities not simulated. You would be saving yourself the bother in the future from users of your data who might wonder whether you had simulated the quantities, but the data files somehow got lost.

0. Pressure, \bar{p} (mb) (F7.1). Omit this file, if pressure is constant over time for all levels.
1. Height, \bar{z} (km) (F7.3). Omit this file, if height is constant over time for all levels.
2. Temperature, \bar{T} (K) (F7.2)
3. Water vapor mixing ratio, \bar{q} (g/kg) (F7.3)
4. Relative humidity, \bar{R} (unitless) (F6.3): $R=q/q^*(T,p)$, where $q^*(T,p)$ is the saturation mixing ratio over water.
5. Cloud water (suspended liquid water) mixing ratio, \bar{q}_c (g/kg) (F7.4)
6. Cloud ice (suspended ice) mixing ratio, \bar{q}_i (g/kg) (F7.4)
7. Rain (falling liquid water) mixing ratio, \bar{q}_r (g/kg) (F7.4)
8. Snow (slow-falling ice) mixing ratio, \bar{q}_s (g/kg) (F7.4)
9. Graupel (fast-falling ice) mixing ratio, \bar{q}_g (g/kg) (F7.4)
10. Cloud fraction, $\bar{\sigma}$ (unitless) (F6.3): At each grid point, $\bar{\sigma} = 1$ if $\bar{q}_c + \bar{q}_i > 0.01 q^*(\bar{T}, \bar{p})$; otherwise, $\bar{\sigma} = 0$.
11. Horizontal wind velocity in x-direction, \bar{u} (m/s) (F7.2)
12. Horizontal wind velocity in y-direction, \bar{v} (m/s) (F7.2)
13. Apparent heat source, Q_c (K/day) (F7.2):
$$Q_{1c} \equiv Q_1 - Q_R = \left[\partial \bar{T} / \partial t - \left(\partial \bar{T} / \partial t \right)_{L.S.} \right] - Q_R$$
14. Apparent moisture sink, Q_2 (K/day) (F7.2):

$$Q_2 = - \frac{L}{c_p} \left[\frac{\partial \bar{q}}{\partial t} - \left(\frac{\partial \bar{q}}{\partial t} \right)_{L.S.} \right]$$

15. Convective Q_{1C} , Q_{1C}^c (K/day) (F7.2): Contribution to Q_{1C} from the “convective” columns.
16. Stratiform Q_{1C} , Q_{1C}^s (K/day) (F7.2): Contribution to Q_{1C} from the “stratiform” columns.
17. Convective Q_2 , Q_2^c (K/day) (F7.2): Contribution to Q_2 from the “convective” columns.
18. Stratiform Q_2 , Q_2^s (K/day) (F7.2): Contribution to Q_2 from the “stratiform” columns.
19. Radiative heating rate, Q_R (K/day) (F7.2)
20. Solar (short-wave) radiative heating rate, Q_R^{SW} (K/day) (F7.2)
21. Infrared (long-wave) radiative heating rate, Q_R^{LW} (K/day) (F7.2)
22. Clear radiative heating rate, Q_R^{clr} (K/day) (F7.2): The average radiative heating rate in the “clear” columns.
23. Cloudy radiative heating rate Q_R^{cld} (K/day) (F7.2): The average radiative heating rate in the “cloudy” columns.
24. Cloud mass flux, M_c (mb/s) (F8.5): $M_c = M_u - M_d$
25. Updraft cloud mass flux, M_u (mb/s) (F7.5):

$$M_u = \frac{\sum_j \sigma \omega^+}{\sum_j},$$

where j is the grid point column index, σ is the cloud fraction (defined previously), $\omega^+ = \omega$ if $\omega < 0$, otherwise, $\omega^+ = 0$.

26. Downdraft cloud mass flux, (mb/s) (F7.5): $M_d = M_{ds} + M_{du}$,

where M_{ds} and M_{du} are the saturated and unsaturated downdraft cloud mass fluxes:

$$M_{ds} = \frac{\sum_j \sigma \omega^-}{\sum_j}$$

and

$$M_{du} = \frac{\sum_j \sigma_p \omega^-}{\sum_j}.$$

Here, $\omega^- = |\omega|$ if $\omega > 0$, otherwise, $\omega^- = 0$. Also, $\sigma_p = 1$ if $\sigma = 0$ and $q_r + q_s + q_g > P$, with $P = 0.1$ g/kg; otherwise, $\sigma_p = 0$.

27. Fractional area of updraft cores, $\overline{\sigma_u}$ (unitless) (F6.3): A “core” exists if $|\omega| > W$, with $W = 0.1$ mb/s. Thus,

$$\overline{\sigma_u} = \frac{\sum_j \sigma_u}{\sum_j}$$

where $\sigma_u = 1$ if $\omega < -W$; otherwise, $\sigma_u = 0$.

28. Fractional area of downdraft cores, $\overline{\sigma_d}$ (unitless) (F6.3):

$$\overline{\sigma_d} = \frac{\sum_j \sigma_d}{\sum_j},$$

where $\sigma_d = 1$ if $\omega > W$; otherwise, $\sigma_d = 0$.

29. Average core updraft speed, ω_u (mb/s) (F7.3):

$$\omega_u = \frac{\sum_j \sigma_u \omega}{\sum_j \sigma_u}.$$

30. Average core downdraft speed, ω_d (mb/s) (F7.3):

$$\omega_d = \frac{\sum_j \sigma_d \omega}{\sum_j \sigma_d}.$$

31. Hydrometeor fraction, $\overline{\sigma_h}$ (unitless) (F6.3): At each grid point, $\sigma_h = 1$ if $\sigma = 1$ or $q_r + q_s + q_g > E = 10^{-3}$ g/kg; otherwise, $\sigma_h = 0$.

3.1.2 Time-series quantities

Submit the results for each of the three groups of quantities listed below, each group in a separate ASCII file, as described in Section 3.2.2. For any quantity that is not available in your model, a required “fill” value must appear in its position, as a constant over time (3.2.2, Note B). If all quantities in a group are unavailable, a dummy file that’s empty should be created, and given with the file name suffix “.not_simulated”.

Group 1:

1. Time of mid-point of averaging interval, \bar{t} (h) (F6.1)
2. Surface skin temperature, SST (K) (F7.2)
3. Near-surface dry static energy, $\overline{s_0}$ (kJ/kg) (F7.2): $s = c_p T + gz$. “Near-surface” is the first model level above the surface.
4. Near-surface water vapor mixing ratio, $\overline{q_0}$ (g/kg) (F6.2)
5. Near-surface moist static energy, $\overline{h_0}$ (kJ/kg) (F7.2): $h = s + Lq$.
6. Near-surface horizontal wind velocity in x-direction, $\overline{u_0}$ (m/s) (F7.2)
7. Near-surface horizontal wind velocity in y-direction, $\overline{v_0}$ (m/s) (F7.2)
8. Surface turbulent flux of sensible heat, $\overline{(F_s)_0}$ (W / m²) (F6.1): $F_s \equiv \rho c_p \left(\frac{p_0}{\bar{p}} \right)^{R/c_p} \langle \omega' T' \rangle$.
9. Surface turbulent flux of latent heat, $\overline{L(F_q)_0}$ (W / m²) (F6.1): $F_q \equiv \rho \langle \omega' q' \rangle$.
10. Surface turbulent flux of horizontal momentum component in x-direction, $\overline{(F_u)_0}$ (nt / m²) (F8.4): $F_u \equiv \rho \langle u' \omega' \rangle$.

11. Surface turbulent flux of horizontal momentum component in y-direction, $\overline{(F_v)_0}$ (nt / m^2)
(F8.4): $F_v \equiv \rho \langle v' \omega' \rangle$.
12. Boundary layer depth, $\overline{Z_i}$ (m) (F6.0)

Group 2:

1. Time of mid-point of averaging interval, \bar{t} (h) (F6.1)
2. Surface downwelling solar radiative flux, $\overline{(F_{SW}^-)}_0$ (W / m^2) (F7.1)
3. Surface upwelling solar radiative flux, $\overline{(F_{SW}^+)}_0$ (W / m^2) (F7.1)
4. Surface downwelling infrared radiative flux, $\overline{(F_{LW}^-)}_0$ (W / m^2) (F6.1)
5. Surface upwelling infrared radiative flux, $\overline{(F_{LW}^+)}_0$ (W / m^2) (F6.1)
6. TOA (top of atmosphere) downwelling solar radiative flux, $\overline{(F_{SW}^-)}_T$ (W / m^2) (F7.1)
7. TOA upwelling solar radiative flux, $\overline{(F_{SW}^+)}_T$ (W / m^2) (F6.1)
8. TOA upwelling infrared radiative flux (OLR), $\overline{(F_{LW}^+)}_T$ (W / m^2) (F6.1)
9. Cloud amount, $\overline{A_{cld}}$ (unitless) (F6.3): Fraction of columns which are “cloudy” for CRMs.
For SCMs, this depends on cloud layer overlap assumptions.
10. Cold cloud top area, $\overline{A_{cld}^{cold}}$ (unitless) (F6.3): Fraction of columns for which the “cloud top temperature” is less than 245 K.
11. Precipitable water, PW (kg / m^2) (F6.2): $\text{PW} = \int_0^{z_T} \rho q \, dz$, where z_T is the model top height.
12. Cloud liquid water path, LWP (kg / m^2) (E10.3): $\text{LWP} = \int_0^{z_T} \rho q_c \, dz$.
13. Cloud ice path, IWP (kg / m^2) (E10.3): $\text{IWP} = \int_0^{z_T} \rho q_i \, dz$.

Group 3:

1. Time of mid-point of averaging interval, \bar{t} (h) (F6.1)
2. Vertically integrated rain, RP (kg / m^2) (E10.3): $\text{RP} = \int_0^{z_T} \rho q_r \, dz$.
3. Vertically integrated snow, SP (kg / m^2) (E10.3): $\text{SP} = \int_0^{z_T} \rho q_s \, dz$.

4. Vertically integrated graupel, GP (kg / m^2) (E10.3): $\text{GP} = \int_0^{z_T} \rho q_g dz$.
5. Surface rainfall rate, \bar{P} (mm/day) (F7.2): Calculate from the surface rain accumulated over every time step.
6. Convective surface rainfall rate, \bar{P}_c (mm/day) (F7.2): The contribution to \bar{P} from the “convective” columns.
7. Stratiform surface rainfall rate, \bar{P}_s (mm/day) (F7.2): The contribution to \bar{P} from the “stratiform” columns.
8. Rain fractional area, \bar{A}_r (unitless) (F6.3): Fraction of columns which are “rainy.”
9. Convective fractional area, \bar{A}_c (unitless) (F6.3): Fraction of columns which are “convective.”
10. Stratiform fractional area, \bar{A}_s (unitless) (F6.3): Fraction of columns which are “stratiform.”

3.1.3 How these quantities are to be directed to files, and how the files named

Each vertical profile quantity is to be written out to a separate data file. For time-series quantities, each of their three groups as defined above should be written to a separate file. These files should be in ASCII text formats, as defined in Section 3.2. This has been the easiest way for the vast majority of participants, in which to submit data. However, we will convert submitted data files into the ARM standard format, which is netCDF based, for each participant as soon as the ASCII data files submitted are checked out for readability.

File names for data simulated:

Example – (of a file containing **a profile quantity**)

b1.p4.CCM3_SUNY -- where

‘b’ is a low-case letter indicating the sub-period simulated;
‘1’ is a digit (a dummy constant for now) which is required, and this reserved position may come in handy later when experimental variations should become more refined;
‘p4’ indicates a [vertical] profile file containing the quantity number 4 in Section 3.1.1;
“CCM3_SUNY” is the acronym of your model name, one used (or to be used) in publication. It should not exceed 13 characters and must *not* include any character that has a reserved meaning on the Unix command line (e.g., /, &, \, and any bracketing char.) Please use the *underscore in lieu of the slash* if the latter is part of your acronym, for the purpose of naming your files.

Example – (of a file containing **a group of time-series quantities**)

b1.t2.CCM3_SUNY -- where

‘b’, ‘1’, and ‘CCM3_SUNY’ are the same as above;
‘t’ indicates a time-series file;
‘2’ indicates this file contains the n-th group of time-series variables (where $n = 2$ in this example), per Section 3.1.2.

Dummy (empty) files are required for data not simulated.

Examples –

b1.p31.CCM3_SUNY.not_submitted

where ‘p31’ indicates the vertical profile quantity numbered 31 per Section 3.1.1.

b1.t3.CCM3_SUNY.not_submitted

where ‘t3’ indicate none of the time-series quantities in group 3 is available.

(If some but not all are missing, consult Note C in Section 3.2.2.)

3.2. Formats for Data Files to be Submitted

3.2.1 Format for a .p file containing a profile variable

Submit the results for each quantity listed above as a separate ASCII file in the file format} described in this subsection. Include the time (since initiation time for the sub-period in the forcing data), to the midpoint of the averaging interval of time (hours, F6.1); and also, either (a) the pressure p (mb, F7.3) or (b) the height z (km, F7.3), whichever is independent variable that is constant over time for every vertical level. If omega levels are used, we expect that you can easily supply mean pressures for the sub-period at these levels, as part of the coordinate variable.

Important: If for your model either p or z changes over time, we need you to supply the .p0 (pressure data 2-D array) or .p1 (height data 2-D array) respectively – each in a separate file, in the same manner as for all experimental quantities. If omega levels are used, you must supply both .p0 and .p1 files.

The file structure is line-by-line and blank-delimited, as follows:

New: Immediately upon generating your **.p files**, please check the third line of each file to make sure that none of them has either the “maxes” or “mins” lines corrupted with bad characters, indicating format over- or underflow errors.

In this illustration, nt is the number of time steps reported;
 $p(ip)$ is pressure value at ip -th level (from ground toward TOA);
 $t(it)$ is time value at it -th sample reported; and
 $f(t(it),p(ip))$ is the data value associated with the above.

#Name_of_file model_description(/variant) fieldname(units) Comment (if any)

nlev nt

f_max f_min

p(1_nearest-to-ground) p(2) p(3) ... p(10) [See Note B]

p(11) ... p(nlev-1) p(nlev)

t(1) t(2) t(3) ... t(10)

t(11) t(12) t(13) ... t(20)

...

... t(nt-1) t(nt)

f(t(1),p(1)) f(t(2),p(1)) f(t(3),p(1)) ... f(t(10),p(1))

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f(t(11),p(1)) f(t(12),p(1)) f(t(13),p(1)) ... f(t(20),p(1))
f(t(21),p(1)) f(t(22),p(1)) f(t(23),p(1)) ... f(t(30),p(1))
...
... f(t(nt-1),p(1)) f(t(nt),p(1))
f(t(1),p(2)) f(t(2),p(2)) f(t(3),p(2)) ... f(t(10),p(2))
f(t(11),p(2)) f(t(12),p(2)) f(t(13),p(2)) ... f(t(20),p(2))
f(t(21),p(2)) f(t(22),p(2)) f(t(23),p(2)) ... f(t(30),p(2))
...
... f(t(nt-1),p(2)) f(t(nt),p(2))
.....
.....
f(t(1),p(nlev)) f(t(2),p(nlev)) f(t(3),p(nlev)) ... f(t(10),p(nlev))
f(t(11),p(nlev)) f(t(12),p(nlev)) f(t(13),p(nlev)) ... f(t(20),p(nlev))
f(t(21),p(nlev)) f(t(22),p(nlev)) f(t(23),p(nlev)) ... f(t(30),p(nlev))

... f(t(nt-1),p(nlev)) f(t(nt),p(nlev))

```

Note A --

The max_&_min line contains the maximum value and minimum value, written in the same elemental data format as you use in writing all data values for the variable.

3.2.2 Format for a .t file, containing prescribed time-series variables

Submit the results for each of the three groups of quantities listed above as a separate ASCII file.

The first line of each file is a comment line, that begins with the identifier #, followed by the filename, and then optionally, any further distinguishing characteristics.

New: After the comment line, come **three more header** lines: a line containing **nt** (number of time steps reported); the so-called “maxes” line, which contains the maximum values of the variables reported, preceded by the dummy time value +999.9; and the so-called “mins” line containing the minimum values preceded by the dummy time value -999.9. The latter two lines must have the same format as used for the time-series data lines which follow.

New: Immediately upon generating your **.t files**, please **check** the top three lines of all files to make sure that none of them has either the “maxes” or “mins” line corrupted with bad characters, indicating format over- or underflow errors.

Following the comment line and the line containing **nt**, the structure of the file can be, optionally, either one of fixed formats as illustrated below (and specified in Note B-1) or free formatted with delimiting blanks and fields of comparable precision, of your own choice (Note B-2).

In this illustration, nt is the number of time steps reported;
 Gnf1 stands for Group_n field_1;
 Gnf2 stands for Group_n field_2; etc.
 max(Gnf1) stands for the maximum value for Gnf1.

```
#Name_of_file Model[/variant]_description Comment (if any)
nt
+999.9max(Gnf1)max(Gnf2)max(Gnf3)max(Gnf4)...
-999.9min(Gnf1)min(Gnf2)min(Gnf3)min(Gnf4)...
time(1)Gnf1(time(1))Gnf2(time(1))Gnf3(time(1))Gnf4(time(1))...
time(2)Gnf1(time(2))Gnf2(time(2))Gnf3(time(2))Gnf4(time(2))...
...
...
time(nt)Gnf1(time(nt))Gnf2(time(nt))Gnf3(time(nt))Gnf4(time(nt))...
```

Note A --

The maxes and the mins line should have the same format for the data lines that follow them, as explained next.

Note B-1 --

Suggested format specifications for each time-series group are as follows, in Fortran notation. It is not necessary to add delimiting blanks between the elemental formats (individual variable values). (It won't hurt though, since the blanks will just make your data conformant to the free field format, as in Note B-2.)

For group 1, it is (F6.1,2F7.2,F6.2,3F7.2,2F6.1, 2F8.4,F6.0);

for group 2, it is (F6.1,2F7.1,2F6.1,F7.1,2F6.1,2F6.3,F6.2,2E10.3); and

for group 3 it is (F6.1,3E10.3,3F7.2,3F6.3).

Note B-2 --

Also acceptable is blank-delimited field formats of your own choosing – one line per time step - consistently from line to line. The E(exponential)-format is preferred (over fixed point) avoid any problem with precision. Whatever you do, do the same for the “maxes” and the “mins” line.

Note C --

If you don't plan on submitting a certain field, please write in its format space a negative number with all decimal positions being '8' -- except the exponent positions, which can be just '+00' or '+01'. If all fields in a certain group are unavailable, see Section 3.1.3, regarding the dummy/empty file required.

4 Model Descriptions

In order to compare results from different models, workshop participants are asked to complete the following description relevant for simulations performed for the intercomparison. This description will help to build up the workshop report at the final stage. The following items apply to both SCMs and CRMs. Respond only to those that apply to your SCM. Note that the science theme of Case 4 is to understand that determines the cloud amount in observations and in models. Please provide more detailed information on the cloud parameterizations.

Scientist:

- Name
- Affiliation
- Address
- Email address
- Fax number

Model Name and History:

- Long name [model/variant]
- Acronym
(to be used in graphics & data files naming)
- Short/conversational name (other than acronym, if any)
- Generic predecessor or relative (name/variant, and acronym, whether or not it also takes part in this study)

On attributes listed below, please be as complete as would be required to satisfy the editor of a journal article.

For each additional model you have participating in this study, you need to fill out a separate page. With proper reference, omission of redundant attribute information is allowed (if you write “AsGP” or “AsGR” (As its Generic Predecessor or Relative), and have cited the prior model, where asked (as above).

Model Type: (1D, 2D, 3D)

Numerical Domain:

- Domain size in x-direction:
- Domain size in y-direction:
- Domain size in z-direction:
- Number of grid points in x-direction:
- Number of grid points in y-direction:
- Number of grid points in z-direction:
- Grid size in x-direction:

- Grid size in y-direction:
- Grid size in z-direction (if stretched please specify):
- Time step

Numerical Technique:

- Numerical method (finite-difference, spectral, etc.):
- Advection scheme and its order of accuracy:
- Time scheme and its order of accuracy:
- Dynamical equations (elastic, anelastic, etc.):
- Numerical diffusion (type, order, magnitude of coefficient)
- Lateral boundary conditions:
- Upper boundary condition (Sponge layer, specification, ...):
- Translation velocity of the reference frame
- Other information

Physical Parameterizations:

- Surface flux parameterization for heat, moisture, momentum:
- Longwave radiation parameterization:
- Shortwave radiation parameterization:
- How were radiative fluxes above the computational domain handled?
- Microphysical (2D/3D models) or cloud/convective (1D model) parameterization: type, number of hydrometeor classes, ...
- Turbulence closure scheme (turbulence closure type, variables predicted and diagnosed by - the turbulence closure, closure for turbulent length scale, ...)
- Other information

Documentation:

Please provide references that more fully describe your model.

- Documentation (present model), if available.
- Documentation (predecessor or relative) – optional if the preceding is available.

5. Plan

We will ask for volunteers to carry out detailed observational analysis of the individual events. These observational analyses will be used to guide the model intercomparison for these events.

6. Time Table

6.1. Soliciting & Accepting Preliminary Results

<i>Time frame</i>	<i>What a participant shall do</i>
(A) Feb.11 – Feb.19	<ul style="list-style-type: none">• Preview, and comment, on this document and the Web page, http://dev.www.arm.gov/docs/scm/scmic4 (<i>developmental site</i>)• Declare interest in joining the preliminary study, by sending E-mail Ric.Cederwall@arm.gov
(B) Feb.19 –	<ul style="list-style-type: none">• Catch up on updates on this document, and its new requirements (if any). http://www.arm.gov/docs/scm/scmic4 (<i>official site</i>)
Feb.19 – Mar.17	<ul style="list-style-type: none">• Conduct simulation runs – per updated requirements; and submit results, and see them through verification and acceptance.

6.2. Processing & Comparing Preliminary Results

- (C) Mar.7 – Mar.21
- View results of evaluation and intercomparison of models.
 - Download netCDF or ASCII data, for your own use.

6.3. Discussing Preliminary Results

- Mar. 31 – Apr. 4, 2003:
- ARM Science Team Meeting in Bloomfield (near Denver), CO.